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AUTHOR Swanson, Richard A., Ed.; And Others
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ABSTRACT

This monograph describes industry at a point in time from the perspective of the faculty in Industrial Education at the University of Minnesota. Section 1 describes the effort to define industry from the perspective of the industrial, business, and economic literature. The remainder of this section is divided into the two components of analysis and synthesis. The analysis of the literature provides the basis of a more articulate definition of industry. Industry is defined as the sector of economic activity that produces and services goods. This analysis section is organized by two major perspectives: understanding industry through definition and understanding industry through classification. The synthesis section discusses the implications for industrial education in terms of proposed curriculum boundaries and structure. Section 2 produces an explicit model of industry using both the definition and classification levels discussed in Section 1. The industry definition is reiterated, and four industry clusters are established: manufacturing, construction, communication, and power. Cluster matrices and accompanying definitions provide explicit industry content boundaries for industrial education. Each matrix contains two major axes. Vertical axes define a process unique to the cluster; horizontal axes describe the industry applications unique to the cluster being presented. (YLB)

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A VIEW OF INDUSTRY

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Edited by
Richard A. Swanson

with contributions by

Francis L. Bartholet
David C. Bjorkquist
James M. Brown
Bruce S. Cote
Jeffrey L. Donnerberg
David G. Druker
Rupert N. Evans
William A. Kavanaugh
Robert W. Marquardt
Stephen J. Miletich
David J. Pucel
Charles P. Quistad
William E. Schoonmaker
Brandon B. Smith
Keith E. Summers
Jeanne E. Weber

CE042058

Division of Industrial Education
University of Minnesota
St. Paul, Minnesota
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PREFACE

Industrial education has, through industrial arts, vocational-industrial education, and industrial training programs of instruction, held to the purpose of teaching industry. The teaching of industry has been accomplished with varying degrees of fidelity.

The present problem of teaching industry is complicated by changes that are occurring there. First of all, the term industry has lost some of its distinctiveness. As an example, the 1982 Occupational Outlook Handbook, classifies all occupations in the United States labor force as part of industry; either service-producing industry or goods-producing industry. The second complicating change is in the ways in which things are accomplished in industry. There are new organizational structures, management strategies, quality standards, and technologies in industry.

These changes make it important for a field of instruction that claims to teach industry to examine industry and to describe what it is. This description should also help in making a decision about whether or not it is viable to continue teaching industry.

The faculty in Industrial Education at the University of Minnesota, with the leadership of Professor Richard A. Swanson, has looked intently at industry and has described it in this monograph. This is a view of industry at a point in time--a snap-shot--from our perspective. In doing this, we have tried to identify the decision criteria for drawing the boundaries of industry so the reader can recognize the viewpoint that is used. It is not possible to describe an entity as complex as industry without some perspective, but it is important that we try to communicate how our description of industry was developed.

Not everyone will accept the process used here for describing industry. Others may disagree with the description of industry and resulting conclusions. This is expected and accepted. Even so, we hope that this monograph will be useful for all who read it in understanding our view of industry and in developing their own.

David C. Bjorkquist, Head

Division of Industrial Education

SECTION 1: A VIEW OF INDUSTRY

Introduction

The field of Industrial Education--industrial arts, vocational-industrial education, and industrial training--has traditionally purported to teach industry to students for the purposes of a broad understanding and specific occupational preparation. In that industry is the content base and by its nature is ever-changing, the definition of industry is a continuing problem for the profession. It is only natural that regular scholarly debates on the definition of industry be encouraged and consumed by the profession as a basis for charting the field of industrial education.

The complexity of industry and alternate views of industry have created a history of academic tension within industrial education. Compounding this, the professional options open to industrial educators within the past several decades have siphoned off a portion of the industrial education leadership. Some have moved into comprehensive vocational education. These persons have for the most part moved away from industry as a content base and have substituted occupations in the labor market in its place. Others, advocating the arrival of a post-industrial society, have substituted technology for industry as a content base. Another group has traditionally made the developmental tasks of learners their dominant purpose with the study of industry being of secondary concern. For them, the industry component is often subordinated to a methodological role.

Part of the industry definition tradition in industrial education has been the tendency among those in the profession to refer primarily to themselves as the basis of understanding industry. Whether it is a group of industrial educators recalling their past work experience or national surveys on existing practices among instructors, the definitions and resulting curricula are limited without purposeful study of industry. Documentation of rigorous analyses of

industry by industrial educators is only sparsely reported in the literature.

This effort in defining industry purposely excluded industrial education literature. The procedure was to conduct a review of the literature from industry, business, and economics on the definition of industry spanning several decades.

Two computer searches and two manual searches of the literature were conducted. Each reference was obtained, reviewed, and initially classified as addressing or not addressing the industry definition topic. All those references that addressed the topic were recorded on the vertical axis rows of a two-axis matrix. The horizontal axis of the matrix contained columns for each discrete concept that was identified in the literature. At times single references received several checks along their row, one for each concept they introduced. This large matrix was the major literature synthesis tool that was used. The concentrations and patterns of check marks provided the framework by which the literature is presented in this monograph.

The use of the word industry appears to have changed dramatically over the past eighty years. At one time, industry, business, and agriculture were discrete economic activities and concepts. In contemporary language there are numerous references to the banking industry and the agricultural industry. However, banks and farms typically are not thought of as part of industry. The image of an industrial worker is more likely to be that of a person working in a factory, on a construction site, or in a repair shop. What then is the view and definition of industry from the perspective of the industrial, business, and economic literature? This was the fundamental question pursued. The goal has been to develop an image of industry from these viewpoints in order to better define the content base for the field of industrial education.

The remainder of Section I is divided into the two components of analysis and synthesis. The analysis of the literature provides the basis of a more articulate definition of industry. The synthesis section discusses the

implications for industrial education in terms of proposed curriculum boundaries and structure.

Analysis: The Industry Definition Literature

Base of Understanding

Any attempt at reconciling the popular economist's view that "industry is a useless concept" with the popular businessperson's view that "the concept of industry clearly exists" is to be commended (Davies, 1955). This optimistic prodding was in reaction to the fatalistic view that to attempt a precise and meaningful definition of industry would be a vain objective (Wolfe, 1955). The industry definition dilemma is portrayed in the range of these two positions and yet the paucity of definitional debate over the years should be noted.

There has been a continued faint call in the literature on the matter of defining industry. Nightingale (1978), an industrial economist, discusses the confusion over the terms "industry" and "market". He further cites the use of the concept of industry throughout the literature without definition. The intuitive appeal of industry as a concept has intrigued both practitioners and theorists and, thus, a formalized definition void exists (Andrews & Brunner, 1975). In her call for attempts at definition, Robinson (1956) acknowledges that imperfections will always exist. Wolfe (1955), in a more philosophical vein, notes the primary reason for definition, concept, and theory -- "a useful guide to an entry on problems of life" (p. 713). He further notes that theory is not used for deductive purposes. Rather, definition, concept, and theory exist as means of introducing the neophyte to the main elements of industry in the real world. In this vein he goes on to note that "there is at least as much need for clarity and simplicity in our theory as for precision" (p. 173).

The dilemma of precise definition versus simplicity is further highlighted in the literature. While some have focused on the simplication and neophyte learner needs, others have noted the analysis and policy-making perspective

that dictates both a need and structure for more precise definitions of industry (Gould & Kolf, 1964 Andrews, 1949). Whatever the articulation, most would agree that industry is a collective term (Ammer & Ammer, 1917; Andrews, 1949; Nightingale, 1978) and a widely held concept. The strength of industry as a concept is portrayed by Vatter:

> ...the notion of an industry continued a robust life, invigorated not only by common senses but also by its widespread application in the business world, its undeniable analytic usefulness for understanding a great range of theoretical problems, and its high relevance to many public policy decisions (1964, p. 330).

Summary: Base of Understanding. The base of understanding from the industry, business, and economic literature on the definition of industry contains two major notions. The first is the recognition that the presence and concept of industry are important. The second is that more precise definitions of industry are needed, but that they will vary according to their purposes. Furthermore, they will be less than perfect because of the complex nature of industry. This last point does not sound a tone of indifference, rather there is a sense of urgency to get on with the difficult and continuing definitional problem.

In pursuing the analysis of the selected literature two major perspectives arose. There were those who attempted to view the totality of industry and those who attempted to understand industry through classifying its components. These two perspectives, definition and classification, are the two organizers for the remainder of this analysis section.

Understanding Industry Through Definition

Industry definition efforts reported in the literature generally are described in terms of what industry is and what industry is not. Gleaning the many variables and characteristics within the dichotomy allowed the reviewer

to look for patterns of thoughts and generalizations.

What Industry Is. The economist's view quite naturally focuses on financial matters. In doing so, there is some discussion of "market" as a synonym for industry (Nightingale, 1978). While this may be an uncomfortable term for some industrialists, the other extreme of equating industry to manufacturing (Ammer & Ammer, 1977; Gould & Kolb, 1964) is equally discomforting.

Several authors make specific reference to the point that an industry is a producing organization (Andrews, 1949; Gilpin, 1977; Vatter, 1964). Within this definition, the activities of goods-producing are separated from producing services. Additionally, the service sector can be separated into servicing humans and servicing goods, with servicing goods considered a part of industry (Ginzberg & Vojta, 1981). For example, a chiropractor produces a service that is consumed that would not be considered a part of industry. On the other hand, the mechanic who services automobiles--a manufactured product--is classified as a part of industry.

Within the goods-producing perspective one source included both mining and processing as being embodied in industry (Ammer & Ammer, 1977). Generally, the extractive activities of mining, forestry, and oil have been separated in the literature from the goods-producing arena of industry. More significant is the further breakdown of the goods-producing perspective of industry into the categories of durable and nondurable goods (Andrews, 1949; The McGraw-Hill, 1973; Nightingale, 1978). Durable goods are described as having a normal life in use of over three years (Nemmers, 1978). Examples of durable goods include books, automobiles, appliances, and furniture while nondurable goods would include food, clothing, tobacco, and gasoline. Some authorities also include semidurable goods as a third category into which items that last from six months to three years are placed. This would include items

such as shoes, clothing, and other items that fall in the upper end of nondurable and the lower end of durable goods (Ammer & Ammer, 1977).

What Industry Is Not. A view of industry emerges from the literature as authors make it known what industry is not.

Even though people refer to the 'agricultural industry', agriculture is not considered a component of industry (The McGraw-Hill, 1973; Vatter, 1964). Transportation and distribution are also not usually considered a part of industry. Additionally, trade and finance are excluded (Ammer & Ammer, 1977; Vatter, 1964).

While Gilpin (1977) notes that industry is generally concerned with production rather than servicing, he does not close the door on services as being an element of industry. As noted earlier, the separation of the service sector into servicing of goods and personal services lends some clarity to this fast growing sector of the economy (Ginzberg & Vojta, 1981).

Summary: Understanding Industry Through Definition. The literature dealing with industry definition provides several valuable insights. Most often the definitions of industry include the following:

1. Industry is concerned with goods production.
2. Industry produces durable and nondurable goods.
3. Industry includes the servicing of durable goods.
4. Industry exludes several elements of the economy, including the extractive elements of agriculture, forestry, mining, and energy well as transportation, distribution, and finance.

A reasonable definition based on these points is that industry is that sector of economic activity which produces and services goods.

Understanding Industry Through Classification

There have been continued efforts in the literature at classifying the elements of industry. These classification schemes acknowledge the presence

of industry and tend to ignore the broader industry definition question other than by aggregating the classification categories. The proponents of these schemes often seem compelled to account for all the elements of industry. If they are compelled to be all inclusive, deductive analysis of the various classification schemes appears to be useful in developing or adding to a definition of industry.

The debate surrounding the classification schemes is generally focused on validity issues. There are those who argue for the validity of a given scheme and those who argue against it. Thus, the perspective of valid or not valid was selected as the organizer for discussing each of the four classification schemes that emerged from the literature. The schemes include the Standard Industrial Classification (SIC), in industry organization, industry products, and technology.

Standard Industrial Classification (SIC). The SIC is an attempt at defining industry in accordance with the total economic structure of the United States. While it was designed originally for government statistical purposes, business firms often use it for market research (Office of Management, 1972). The SIC Manual is revised periodically to accommodate the changes in industry. Revision proposals are received from many private sector sources and considered by the U.S. Statistical Policy Division. The major categories of the SIC include: agriculture; forestry and fishing; mining; construction; manufacturing; transportation; communication; electric, gas, and sanitary services; wholesale and retail trade; finance, insurance, and real estate; personal business; repair and other services; and public administration.

There are those who tout the validity of the SIC (What Is This Thing Called SIC?, 1976) and some who contend that it has become a standard way of viewing industry (Vatter, 1964). Others make it clear that the SIC is not a valid view of industry (Fertuck, 1975; Nightingale, 1978). They imply that

the original statistical purposes and the political method of revision do not provide a classification scheme of intellectual or practical integrity.

Industry Organization Classification. The grouping of industries is not restricted to the SIC. Andrews (1951) and Andrews and Brunner (1975) have defined an industry as any grouping of individual businesses in which the behavior of any one is relevant to the others. This organization similarity concept has face validity and at the same time is criticized for its lack of empirical validity (Nightingale, 1978). Higgs (1923) reminds the reader of the fact that industries do not exist for the analyst and that industry organization is not due to the conscious endeavor of individuals. Rather, it grows out of the acts of people for their own economic ends.

On a broader base, the criticisms here are similar to those lodged against the SIC. The issue is one of recognizing the intent and method of the classification scheme organization and its resulting deficiencies. While the SIC has a dated rigidity in its classification, the alternative of grouping based upon short term organizational commonalities is strictly an acknowledgement of change without a construct by which to view it.

The Dictionary of Occupational Titles (1977) and the Occupational Outlook Handbook (1982) have not been used as classifications of industry. Their main purpose is to describe occupations. References to industries in these publications primarily are used to group occupations.

Industry Products Classification. Product is used widely as a means of classifying industry (Gilpin, 1977; Robinson, 1932). The breadth or narrowness of the product designator is usually in direct proportion to the economic size of the industry. Thus, the housewares industry--with many products--exists in contrast to the automobile industry--with one major product. Additionally, industry groups are often viewed in terms of the substitutability of their products. Gaps between products are used as the basis for separating groups

(Nemmers, 1978). Vatter (1964) confronts this scheme with the fact that most large industries are multiproduct and that they are not precluded from participation in many such product classifications. Consequently, he goes on to highlight the discrepancies that arise from classification schemes that dwell on the major product and ignore the full range of products.

Technology Classifications. The technology underlying industry or segments of industry can be analyzed in terms of several dimensions. The literature often focuses on processes and the corresponding technical and resource base (Chamberlin, 1947). Consistent with this is Marshall's (1920) view of an industry as having a large number of firms producing in a technologically similar manner. This "common technical attributes" perspective is generally supported in the literature as a means of understanding industry (Andrews, 1949; Andrews & Brunner, 1975; Robinson, 1956).

Nightingale (1978) introduces the concept of "the planning horizon" as an advanced level of classifying industry. The popular use of the terms high technology and low technology industries is certainly a crude measure of the planning horizon phenomenon. Technology, level or type, is presently the least used formal classification scheme. Its lack of use may be the major reason for the lack of overt criticism of this scheme.

Chamberlin (1947) wrote an analysis which may help in the process of understanding industry through classification. He said that we should not "...discard completely the concept of an industry. In many connections it is obviously useful to delimit a portion of the economic system and study it in some degree of isolation from the rest...one emerges from any attempt to classify industries, however, with a feeling that it is all exceedingly arbitrary. The commonsense definition of industries in terms of which practical problems are likely to be studied seems based much more upon technological criteria than upon the possibility of market substitution" (p. 202).

Summary: Understanding Industry Through Classification. The validity of industry as a concept has been further reinforced in the classification literature along with acknowledgement of its amorphous nature. The insights from the classification literature include the following:

1. It is reasonable for a particular group to focus on a portion of industry and to concentrate on that portion for an explicit predisposed purpose.
2. Classification schemes are useful and necessary for industry analysis and understanding.
3. A multidimensional scheme of classifying industry is desirable in that the schemes of organization, products, or technology are in themselves too limited and, thus, individually provide a distorted view of industry.

One obvious point is that industry can be viewed from varying vantage points and varying perspectives result. The original purpose of definition appears to have more than one level. At one level, an explicit statement constituting an industry definition appears to be necessary in order to establish general parameters. Indications from the literature are that this in itself does not appear to be enough. A definition of industry to help form a view of industry for a predisposed reason is also in order. In order to have utility for learning, analysis, and policy making, definitions must reach for and incorporate more operational dimensions in terms of detail and interaction.

Synthesis: Implications for Industrial Education

The implications of this review of literature are fundamental to industrial education. They address the question of what the field of study is all about. The effort here was not to look to industrial education literature for answers, but to draw closer to the primary players in the enterprise called industry through reviewing their literature. There are those in industrial edu-

cation who deny that industry is its content base and those, who under the name of industry, teach industrial knowledges and skills long since obsolete. Increased unity in the industrial education profession is both needed and desired.

The implications in this review seem to fall into three categories. The first is a reaffirmation of industry as a robust and vital concept in the American economic structure. The hailing of the arrival of a post-industrial era apparently does not eliminate the importance and vitality of industry.

The literature reviewed here indicates that the traditional concepts of industry, business, and agriculture are still valid constructs. And it indicates that definitions of industry will always need continual refinement and will always be less than perfect.

The second implication is the need for clearer definition of the portion of industry which industrial education can reasonably attempt to deal with. While industry is concerned with goods production, industrial education has traditionally focused on the segment concerned with the production of durable goods. Additionally, given a common knowledge base for goods production and goods servicing, the inclusion of servicing durable goods is also appropriate. Given the lack of purity in our constructs, stating what industry and industrial education are not is also helpful. For example, the dilemmas in industrial education about the "enterprise perspective" and "transportation" within the cluster approach are handled conveniently in the non-industrial education literature. According to the literature reviewed, the extractive elements--agriculture, mining, forestry, and energy--along with transportation, distribution, and finance are not industry. Industrial education's limited endorsement of content in these domains over the years is further testimony to the perspective of industry held by the profession.

The third implication from the literature is the need for a unifying content framework in industrial education. The literature clearly suggests that

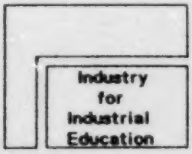
the existing schemes for classifying industry are inadequate. For this reason, a multidimensional view of industry is being proposed. This includes a definition of industry, a focused definition of industry for industrial education, and the conceptualization of industry into a limited number of technological classification components at three levels. These three technological classifications include conceptual clusters and the further definition of the clusters as to their unique technological processes and applications.

The two axes of process and application in each cluster are intended to provide an avenue for professional unity among the individual perspectives of industry among industrial educators. One way of viewing many of the philosophical clashes in industrial education is that industrial educators probably have more agreement as to the specifics of content than they do on how it is accessed (by process or by application). This observation is not meant to diminish the uniqueness of the industry process or industry applications perspectives. It suggests that through the matrix industrial educators can enter it from their bias of process or application and still retain their integrity. By doing this, they can then rationally consider the merits of the alternative axis.

Figure 1 provides a broad definition of industry and a focused industry definition for industrial education derived from the literature. Beyond these, the graphic portrayal the industry clusters and a generic two-axis matrix model (process and application) further illustrate the definition of industry for industrial education.

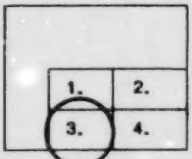
1. Industry Definition

The sector of economic activity which produces and services goods.



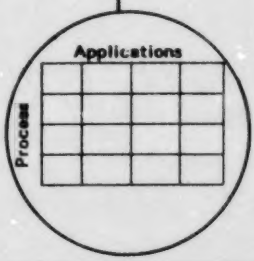
2. Industry Definition for Industrial Education

The American economy has been grouped traditionally into the categories of industry, business, and agriculture in providing the goods and services that society demands. Within the industrial component of the economy, a distinct group of productive enterprises aimed at the production and servicing of durable goods is utilized to conceptualize and study industry for the field of industrial education.



3. Industry Clusters

Conceptual grouping of industry into clusters having technological integrity.



4. Industry Cluster: Process and Application

A definitional matrix that intersects the process steps unique to the cluster with unique cluster applications.

Industry Definition Model Synopsis

Figure 1

SECTION II: A MODEL OF INDUSTRY FOR INDUSTRIAL EDUCATION

Introduction

The purpose of this section is to produce an explicit model of industry utilizing both the definition and classification levels discussed in Section I. It is important to note that the industry model is for the purpose of producing definitive boundaries for the component of industry that the field of industrial education can reasonably handle.

While there are curricular implications resulting from each definitional level--definition, clusters, processes, and applications--the final model is not in itself a curriculum or sequence of courses. The structuring of specific courses to teach industry, as defined by this model, is the next logical task beyond this monograph.

Industry Definition Reiterated

The industry definition was established utilizing the following decision rules. The definition of industry should be:

1. consistent with industry, business, and economic literature concepts and definitions of industry;
2. grounded in industry, business, and economic literature spanning several decades; and
3. neither cryptic nor expansive beyond the point of communicating the basics of the concept.

In light of these criteria and as means of moving ahead with the development model, the following industry definitions are reiterated:

Industry Definition

The sector of economic activity which produces and services goods.

Industry Definition for Industrial Education

The American Economy has traditionally been grouped into the categories

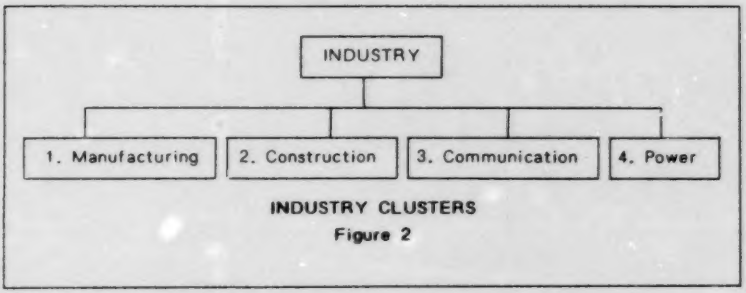
of industry, business, and agriculture in providing the goods and services that society demands. Within the industrial component of the economy, a distinct group of productive enterprises aimed at the production and servicing of durable goods is utilized to conceptualize and study industry for the field of industrial education.

Industry Clusters

A view of industry is clearly specified in the industry definition. In that industry is so large to begin with, it is reasonable to identify that portion that is of concern to industrial education and to divide this portion into sub-groupings. These sub-groupings are referred to as clusters from this point on. The decision rules utilized for establishing the industry clusters were as follows:

1. to establish a limited number of technologically and instructionally manageable (no more than seven) clusters, and
2. to maintain an eveness of cluster content breadth and/or depth.

The process by which the clusters were finally established was not solely a process of taking the definition, following the decision rules, and culling out the clusters. A simultaneous process of developing the axes of the cluster matrices took place to provide a validation of the clusters. Several rounds of this reiterative process on the part of the authors resulted in the following industry clusters (Figure 2).



INDUSTRY CLUSTERS
Figure 2

The logic that was employed to establish the manufacturing and construction clusters in the Industrial Arts Curriculum Project was used here and the processes included in those clusters are based on that project. In order to meet the decision rules of discreteness and breadth/depth eveness, some content shifts took place. For example, it was decided to establish a cluster titled communication. In this instance, the communication cluster encompasses the production of visual images to transfer ideas for the purposes of goods production, marketing, and media. The design of manufactured and constructed products is embraced within communication and leaves those two clusters without a design component in their processes. They begin with production steps rather than design. Additionally, the 'manufacturing' of marketing and media communication products is handled within the communication cluster and not in manufacturing. This includes manufactured products such as books, screened posters, slide-shows, videotapes, and photographs.

The power area is grounded in the theoretical underpinnings of electrical, mechanical, and fluid power. This differs from the sequential technological process that undergirds manufacturing and construction. Furthermore, expertise in power is viewed in this cluster model as having primary utility at the design and servicing ends of industrial practice. In-depth knowledge of power is least useful in the production phase of the process. Thus, within these four clusters, the specific knowledge needed to design power systems is retained within the power cluster. The general graphic tools needed to record design solutions are located in the communication cluster.

The following cluster matrices and accompanying definitions (Figures 4-7) provide explicit industry content boundaries for industrial education. As noted in Section I each matrix contains two major axes. The vertical axes defines a process that is unique to the cluster. The horizontal axes describe the industry applications unique to the cluster being presented.

Summary

A great deal of the talk about change in American culture from Future Shock (Toffler, 1970) to Megatrends (Naisbitt, 1982) has to do with American industry. Most agree that industry as we have known it will change radically from smokestacks to chips, and from goods-producing to goods-servicing.

The model of industry presented in this monograph is designed to cope with the ambiguities of the future and the demands of the present. The model presented is a view of present day industry in a framework that can embrace change.

MANUFACTURING

CLUSTER DEFINITION:
The in-plant production of durable goods by custom and mass produced methods.

A. MANUFACTURING PROCESS	B. MANUFACTURING APPLICATION			
	1. Custom Produced		2. Mass Produced	
	LABOR INTENSIVE	MACHINE INTENSIVE	LABOR INTENSIVE	MACHINE INTENSIVE
1. CONVERTING RAW MATERIALS into INDUSTRIAL MATERIALS				
2. MAKING INDUSTRIAL MATERIALS into STANDARD STOCK				
3. MAKING COMPONENTS or FINISHED PRODUCTS				
4. MAKING ASSEMBLIES or FINISHED PRODUCTS				
5. PREPARING for DISTRIBUTION				
6. SERVICING MANUFACTURED GOODS				

Figure 3. Manufacturing

Figure 3 (cont'd)

MANUFACTURING DEFINITIONS

A. MANUFACTURING PROCESS

1. **Converting Raw Materials to Industrial Materials.** Raw materials are processed to remove the nonusable ingredients before they are converted into goods.
2. **Making Industrial Materials into Standard Stock.** Standard stock (such as standard size and grade wood, steel, glass, etc.) is made so the materials can be processed by the available manufacturing equipment.
3. **Making Components or Finished Products.** A finished product may be made up of many manufactured parts or consist of only one part.
4. **Making Assemblies or Finished Products.** Components are assembled to become a finished product.
5. **Preparing for Distribution.** Finished products are usually stored in a warehouse until orders are received from the end users. Finished products are loaded onto trucks, boats, planes, or railcars to be transported to the consumer.
6. **Servicing Manufactured Goods.** Maintenance and repair of manufactured goods after production and during the lifespan of the product.

B. MANUFACTURING APPLICATION

1. **Custom Produced-Labor Intensive.** The custom manufacture of an item utilizing minimal tool use and maximum hand work.
2. **Custom Produced-Machine Intensive.** The custom manufacture of an item utilizing maximum machine tool/technological capability.
3. **Mass Produced-Labor Intensive.** The mass production of a product utilizing methods which are heavily dependent on worker labor.
4. **Mass Produced-Machine Intensive.** The mass production of a product utilizing methods approaching cybernetic control of the process (machines controlling machines).

CONSTRUCTION

CLUSTER DEFINITION:

The on-site production of residential and non-residential structures.

A. CONSTRUCTION PROCESS	B. CONSTRUCTION APPLICATION				
	1. RESIDENTIAL		2. NON—RESIDENTIAL		
	SINGLE UNIT	MULTIPLE UNIT	COMMERCIAL	INDUSTRIAL	CIVIL
1. PREPARING the SITE					
2. SETTING FOUNDATIONS					
3. BUILDING STRUCTURES					
4. INSTALLING UTILITIES					
5. ENCLOSING STRUCTURES					
6. FINISHING SURFACES					
7. LANDSCAPING the SITE					
8. SERVICING PROPERTY					

Figure 4. Construction

Figure 4 (cont'd)

CONSTRUCTION DEFINITION

A. CONSTRUCTION PROCESS

1. **Preparing the Site.** Clearing the site of vegetation, earthmoving and stabilization, in preparation for location of the foundation.
2. **Setting the Foundation.** Forms are built from foundation blueprints and reinforcement is put in place. Concrete is then poured into the forms and finished.
3. **Building Structures.** The building of a structure using steel, concrete and/or wood as a support material.
4. **Installing Utilities.** The placement of utilities including electrical wiring, heating and cooling systems, plumbing and communication systems.
5. **Enclosing Structures.** Upon completion of the support structure, interior and exterior walls are insulated and covered. Floors and ceilings are enclosed in a similar manner.
6. **Finishing Surfaces.** The exterior and interior surfaces are treated for preservation and appearance. Surface and penetrating finishes are used, along with various types of wall and floor coverings.
7. **Landscaping the Site.** Upon completion of the structure, exterior fixtures are installed and grounds area is landscaped using a variety of vegetation.
8. **Servicing Property.** During the useable lifespan of the structure, maintenance is performed on the structure, with any alterations or repairs being completed.

B. CONSTRUCTION APPLICATION

1. **Residential.** Single or multiple unit residence. Frame houses and apartment complexes are examples of these types of structures.
2. **Non-Residential.** Structures such as bridges, antennas, commercial/industrial buildings, and highways.

COMMUNICATION

CLUSTER DEFINITION:

The production of visual images to transfer ideas for the purposes of goods production, marketing, and media.

A. COMMUNICATION PROCESS	B. COMMUNICATION APPLICATION			
	1. PRODUCTION		2. MARKETING & MEDIA	
	MANUFACTURING	CONSTRUCTION	HARD COPY	PROJECTED IMAGES
1. COMMUNICATION GOAL and AUDIENCE				
2. METHODS of DISSEMINATION				
3. VISUALIZATIONS and ALTERNATIVE SOLUTIONS				
4. REPRESENTATION				
5. SPECIFICATIONS				
6. PROTOTYPES				
7. PRODUCTION				
8. DISSEMINATION				

Figure 5. Communication

Figure 5 (cont'd)

COMMUNICATION DEFINITIONS

A. COMMUNICATION PROCESS

1. **Communication Goal and Audience.** Identification of major objective of the communication problem and the audience trying to be reached.
2. **Method of Dissemination.** The medium used to deliver the solution of the communication problem.
3. **Visualization and Alternative Solutions.** Generation of multiple ideas to solve the communication problem.
4. **Representation.** Generation and modification of a specific solution used to fulfill the communication goal.
5. **Prototypes.** Actual size model. The general configuration of a design, as well as the major parts, which give the most accurate impression of the finished design.
6. **Specifications.** The explanatory notes, general and specific, and information concerning details of materials and production.
7. **Production.** Producing of the hard copy/projected images using a wide variety of methods.
8. **Dissemination.** Distribution of materials produced using the technique applicable for the specific audience.

B. COMMUNICATION APPLICATION

1. **Production.** Visualization and graphic methods for designing manufactured and constructed goods.
2. **Marketing and Media.** Visualization and graphic methods for designing and producing printed and projected products.

POWER

CLUSTER DEFINITION:

The conversion and control of power for communication, transportation, and production systems.

A. POWER PROCESS	B. POWER APPLICATION						
	1. FUNDAMENTAL SYSTEMS			2. COMPLEX SYSTEMS		
	ELECTRICAL POWER	MECHANICAL POWER	FLUID POWER	COMMUNICATION	TRANSPORTATION	PRODUCTION
1. DESIGN						
2. OPERATION						
3. MAINTENANCE						
4. ANALYSIS						
5. FABRICATION						
6. DIAGNOSIS						
7. REPAIR						

Figure 6. Power

Figure 8 (cont'd)

POWER DEFINITIONS

A. POWER PROCESS

1. **Design.** Creation of a new power machine or system using existing subsystems or by devising new ones.
2. **Operation.** Putting a machine or system into action; running the same.
3. **Maintenance.** The routine inspections, adjustments, lubrication, etc., required by a machine or system.
4. **Analysis.** A way of gaining insight into a machine or system by breaking its total operation into discrete, quantifiable actions.
5. **Fabrication.** Building or making machines or systems that generate or control power.
6. **Diagnosis.** Creative but systematic investigation into the causes of any system function or malfunction.
7. **Repair.** Restoration of a machine or system to original operating condition after long service or a breakdown.

B. POWER APPLICATIONS

1. **Electrical Power.** Electrical and electronic apparatus.
2. **Mechanical Power.** Mechanisms and movements, including engines.
3. **Fluid Power.** Hydraulic and pneumatic power devices.
4. **Communication.** Systems using electronic, optical, and other means, to convey and process information.
5. **Transportation.** Systems that move people and materials.
6. **Production.** Systems using power devices in manufacturing and construction.

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